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The Effects of Pre-Procedural Mouth Rinses on Shear Bond Strength of Orthodontic Brackets: an in-Vitro Comparative Study

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Abstract

Aim: The use of pre-procedural mouth rinse for prevention of COVID-19 can reduce viral load but can alter the bond strength. The purpose of this study was to determine any correlation between the use of these pre-procedural mouth rinse and the shear-bond strength (SBS) of orthodontic brackets.
Methods: Thirty-three maxillary premolars extracted for orthodontic purposes were used. The buccal surfaces of all teeth were bonded with orthodontic brackets. Later, each tooth was embedded into acrylic resin and stored in distilled water. Teeth were randomly divided into three groups (group I: hydrogen peroxide mouth rinse, group II: povidone-iodine mouth rinse, and group III: artificial saliva), and stored in each solution for 12 hours. Later, each tooth was subjected to SBS testing using a universal testing machine. Data were statistically evaluated using one-way analysis of variance (ANOVA) and post hoc test (Tukey's HSD) with a significance of $p< 0.05$.
Results: The highest mean SBS was observed in the artificial saliva (control group), followed by the povidone-iodine and hydrogen peroxide groups.
Conclusion: Hydrogen peroxide mouth rinses should not be used during fixed orthodontic treatment because it alters bond strength.

Keywords: Orthodontic brackets, Mouth rinse, Shear bond strength

1. Background

To obtain favorable outcomes in orthodontics, clinicians must consider bonding strengths of orthodontic brackets to enamel. Debonding of brackets during treatment, is unfavorable and delays orthodontic treatment. Several factors have been suggested, including deficient operator technique, moisture contamination, changes in enamel surface, masticatory forces, and food stimulants and soft drinks (1).

The sudden outbreak of the corona virus disease in 2019 (COVID-19) that leads to respiratory disease due to SARS-CoV-2 infection, has led to widespread health problems and concerns (2). The danger of the COVID-19 virus transmission through saliva is very high and the droplets from dental treatment can remain for many hours in the air, possibly leading to numerous transmissions (3). Hence, precaution and preventive care should be considered even in asymptomatic carriers (4). One of the suggested ways to decrease viral load in dental environment is to use adequate pre-procedural mouthwashes (5,6).

The purpose of this study was to determine the association between application of these pre-

procedural mouth rinses and the shear-bond strength (SBS) of orthodontic brackets.

2. Methods

Thirty-three human premolar teeth extracted for orthodontic reasons were retained and stored in physiological saline solution. The sample size was decided using the statistical software G*Power. The patients were notified of the study and necessary consent forms were signed. Exclusion criteria were teeth with hypoplastic areas, decalcifications, caries, cracks, or severe irregularities of the enamel structure. The soft tissue debris of all teeth were detached.

The buccal surfaces of all teeth were cleaned with fluoride-free pumice and rubber cup for 10 seconds. Next, the teeth were washed using a 3 in 1 (air/water) syringe for 15 seconds, dried with oil-free compressed air for 15 seconds, and etched for 30 seconds on the buccal surface using 37% phosphoric acid. Then the buccal surface was washed for further 60 seconds using a water syringe, and dried with oil-free compressed air.

The brackets (Mini Diamond, Ormco, Orange, California, USA) were bonded to the teeth with a light cured adhesive (Enlite, Ormco, Orange, California, USA). During bracket positioning, force gauge was used to deliver uniform pressure. The brackets were positioned at the center of the buccal surface of the tooth. Before curing, surplus adhesive was detached with a sharp scaler. The procedures were performed by a single trained and calibrated operator.

The teeth were randomly placed into two experimental groups and one control group with 11 teeth each.

Group I: 0.5% Povidone iodine (3M India Ltd., Pune, Maharashtra, India) (Fig. 1A). The samples were rinsed in povidone iodine for 60 seconds and then washed with water for 10 seconds. To simulate for 1 year the process was repeated 12 times every hour, where each hour represented one month.

Group II: 0.6 % Hydrogen peroxide (Padmavahi chemicals, Bangalore, Karnataka, India) (Fig. 1B). The samples were rinsed in hydrogen peroxide for 60 seconds and then washed with water for 10 seconds. When not in use, the samples were stored in artificial saliva. This process was repeated 12 times every hour with each hour representing one month.

Group III: Control group (Fig. 1C). The samples were stored in artificial saliva for twelve hours.

Artificial saliva was changed every hour in all three groups. After twelve hours, all teeth were mounted vertically in acrylic blocks.

After that, the samples were kept in distilled water at 37°C for 24 hours before testing bond strength. The brackets were debonded using a shear-peel load on a universal testing machine (UNITEK 9450, Pune, Maharashtra, India) at a crosshead speed of 1 mm/min (Fig. 2). The load was recorded at bond failure and used to calculate the bond strength using the following formula:

$$\frac{\text{Stress at failure (N)}}{\text{Shear bond strength (Mpa)}} = \text{Area of bracket base } \left(\text{in mm}^2\right)$$

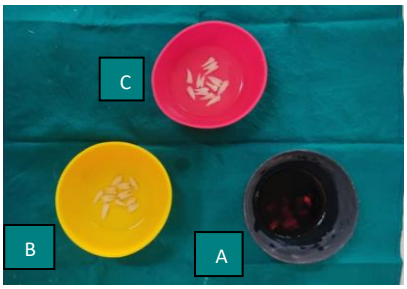

Figure 1. Extracted teeth at different agents. A: artificial saliva, B: 0.6% hydrogen peroxide, and C: 0.5% povidone iodine

Figure 2. Teeth mounted on acrylic blocks and tested on universal testing machine

Bond strength results were obtained with the aid of a computer program connected to the universal testing machine

Descriptive analysis was performed using mean and standard deviation for quantitative variables. ANOVA was used to compare the mean values of quantitative parameters between the three groups.

If ANOVA revealed a statistically significant difference, the relevant post-hoc test (Tukey's HSD) was applied to determine the statistical significance of pair-wise comparisons.

P-value<0.05 was considered statistically significant.

3. Results

Total 33 extracted premolar teeth were included in the final analysis (11 in each group).

The results showed that the shear bond strength of the artificial saliva was highest (19.97 ± 1.8 MPa) and hydrogen peroxide mouth rinse was lowest (17.27 ± 0.93 MPa) (Table 1).

Post hoc test (Tukey's HSD) indicated no statistically significant difference between PVI and H2O2 mouth rinse groups (P = 0.220). However, the artificial saliva showed better shear bond strength compared to both the mouth rinse and the difference was statistically significant (p<0.05) (Table 2&3).

Table 1. Descriptive analysis of shear bond strength in teeth immersed in different solutions.

Groups	Parameter	Number N	Mean +/- SD	Minimum	Maximum	P-value	F-value
Group I: Teeth immersed in Povidone-iodine	Shear Bond Strength (MPa)	11	18.32 ± 1.46	16.60	20.20	<0.05	9.802
Group II: Teeth immersed in Hydrogen Peroxide	Shear Bond Strength (MPa)	11	17.27 ± 0.93	15.20	18.50	<0.05	9.802
Group III: Teeth immersed in Artificial saliva	Shear Bond Strength (MPa)	11	19.97 ± 1.8	18.10	23.10	<0.05	9.802

MPa=Mega pascals

Table 2. Comparison of shear bond strength across three groups

Parameter	Study groups (Mean ± SD)			
	Group I	Group II	Group III	P value
Shear Bond strength	18.31 ± 1.45	17.27 ± 0.92	19.9 ± 1.79	<0.001

MPa=Mega pascals

Table 3. Pair-wise comparison of shear bond strength across study groups (post-hoc test)

Pair-wise comparison of shear bond strength	P value
SBS with Group I vs. Group II	0.220
SBS with Group II vs. Group III	0.030
SBS with Group II vs. Group III	<0.001

4. Discussion

COVID-19's unexpected pandemic started toward the end of 2019, brought about considerable dilemmas and distress. Given the importance of saliva in spread of COVID-19 virus, it is wise to regard the possibility of existence of this virus in saliva of even asymptomatic carriers (4,5). Saliva has a critical role in disseminating the infection via spread of virus-infected droplets. By utilizing an efficient mouth rinse and decreasing the load of COVID-19 virus in the mouth, disease transmission will be minimized. Broad spectrum antimicrobial mouth rinses are widely accessible options for reducing pathogens. Because of the vulnerability of the viruses to oxidation, a pre-procedural oxidizing mouth rinse such as H2O2 or povidone iodine may be worthwhile (7-9). A study conducted by de Souza et al. found that using PVP-I mouth rinse reduces viral load of SARS-CoV and MERS-CoV in the saliva by a significant amount. Because of its high antiviral characteristics, this mouth rinse helps reduce the existence of viruses in droplets and aerosols. In addition, recent studies have suggested that this mouth rinse can be used before dental treatments in the COVID-19 crisis to reduce disease transmission (5,10).

The present study was done to evaluate the effect of these pre-procedural mouth rinses on the shear bond strength of orthodontic brackets. Several commercial mouth rinses are available in the market but we tested two different kinds of commercial mouth rinses, i.e., povidone iodine and hydrogen peroxide mouth rinses.

Demir et al. (11) in their study used chlorhexidine and povidone iodine mouth rinses before and after etching. Results showed that, compared to chlorhexidine, povidone-iodine had

higher SBS of the orthodontic composite resin when applied before etching the enamel surface. However, using a test solution on the etched surface did not influence the SBS of orthodontic composite resin when compared with control values. In present study, when povidone iodine was used as a pre-procedural mouth rinse, the SBS of the composite decreased compared to the control group (artificial saliva).

In a systematic review study, Imani et al (12) evaluated the effect of hydrogen peroxide bleaching on the strength of orthodontic brackets, and found that irrespective of the concentration of hydrogen peroxide and duration of time interval between bleaching and bonding procedures, bleaching prior to bonding can decrease the shear bond strength by up to 3.25 MPa. Similarly, in present study, hydrogen peroxide mouth rinse also reduced the shear bond strength of the orthodontic brackets.

Jamilian (13) studied the effects of two commercial mouth washes and artificial saliva on the SBS of metallic orthodontic brackets bonded to teeth. He concluded that the artificial saliva had the highest and commercial mouth rinses had the least SBS because of their chemical ingredients. Similarly, in present study, povidone iodine and hydrogen peroxide mouth rinses had the least SBS compared to artificial saliva.

In a study conducted by Bistey et al., they concluded that when H2O2 had a concentration higher than 20% and was used for longer than 60 minutes, the enamel bond strength reduced. This is probably due to the considerable surface structural modification resulting from reduction in the phosphate ions. In present study, bond strength reduced when 0.6% H2O2 was used for 60 seconds for 12 cycles (14).

The highest mean shear bond strength was noted in control group, followed by the povidone iodine group, and the least SBS was found in the hydrogen peroxide group. Hence, hydrogen peroxide mouth rinses should not be used during fixed orthodontic treatment because it lowers the bond strength of orthodontic brackets.

Limitations of the study:

Due to the *in-vitro* design of the present study, exact clinical situations and patient related factors such as pH of the oral cavity, the effect of diet, and oral hygienecould not be simulated.

Future scope of the study:

In vivo, prospective, multi-centered clinical trials with larger sample sizes should be done to confirm the above results.

Conclusion

Given the limitations of the study, the impact of pre-procedural mouth rinses and artificial saliva on the shear bond strength of the orthodontic brackets bonded with composite resin were compared and the conclusion is as follows:

The highest shear bond strength was noted in the artificial saliva (control group), followed by the povidone iodine, and hydrogen peroxide group. Hence, hydrogen peroxide mouth rinses should not be used in patients undergoing fixed orthodontic treatment because it diminishes the bond strength.

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